

b) Pending Claims:

Claims 19, 50, 60, 68, 78, 86, and 100 are amended as follows. Under 37 C.F.R. § 1.173 all amendments are made relative to the original patent. Thus, all claims not present in the original patent are underlined, including those not amended.

19. (Three Times Amended) A microwave plasma processing apparatus comprising:

a plasma generation chamber provided with a first dielectric material;

a processing chamber connected to said plasma generation chamber;

means for supporting a substrate to be processed, provided in said processing chamber;

microwave introduction means utilizing an endless annular wave guide with a plurality of slots having defined positions in the endless annular wave guide for radiating microwaves therethrough provided outside of said first dielectric material;

means for introducing gas for said plasma generation chamber and said processing chamber; and

evacuation means for said plasma generation chamber and said processing chamber;

wherein an interior of said annular wave guide tube is filled with a second dielectric material which is the same as or different from said first dielectric material so that the wavelength of microwaves in said wave guide is shortened, [whereby increased slot density providing a uniform high-density plasma is obtained] wherein the defined positions of the slots depend on the shortened wavelength of the microwaves in the presence of the second dielectric, thereby generating a uniform high density plasma.

50. (Three Times Amended) A microwave plasma processing method wherein a substrate is placed in a microwave plasma processing apparatus comprising a plasma generation chamber provided a first dielectric material; a processing chamber connected to the plasma generation chamber; means for supporting a substrate to be processed, to be placed in the processing chamber; microwave introduction means utilizing an endless annular wave guide provided with plural slots having defined positions in the endless annular wave guide for radiating microwaves therethrough provided outside of said first dielectric material; means for introducing gas for said plasma generation chamber and said processing chamber; and evacuation means for said plasma generation chamber and said processing chamber, wherein the interior of said annular wave guide tube is filled with a second dielectric material which is the same as or different from the first dielectric material, so that the wavelength of microwaves in said wave guide is shortened, [whereby increased slot density providing a uniform high-density plasma is obtained] wherein the defined positions of the slots depend on the shortened wavelength of the microwaves in the presence of the second dielectric, thereby effecting a plasma process.

60. (Three Times amended) A microwave plasma processing apparatus comprising:
a plasma generation chamber provided with a first dielectric material;
means for supporting a substrate to be processed;
microwave introduction means utilizing an endless annular wave guide with a plurality of slots having a defined position in the endless annular wave guide for radiating microwaves therethrough provided outside of said first dielectric material;
means for introducing gas into said plasma generation chamber; and

evacuation means for said plasma generation chamber;

wherein an interior of said wave guide is filled with a second dielectric material which is the same as or different from said first dielectric material so that the wavelength of microwaves in said wave guide is shortened, wherein the defined positions of the slots depend on the shortened wavelength of the microwaves in the presence of the second dielectric, thereby generating a uniform high density plasma.

61. A microwave processing apparatus according to claim 60, where the wave guide has a cylindrical shape.

62. A microwave processing apparatus according to claim 60, where the wave guide has a disk shape.

63. A microwave processing apparatus according to claim 60, where the wave guide has a shape which follows the exterior of the first dielectric material.

64. A microwave processing apparatus according to claim 60, further comprising a processing chamber connected to said plasma generation chamber.

65. A microwave processing apparatus according to claim 64, where the wave guide has a cylindrical shape.

66. A microwave processing apparatus according to claim 64, where the wave guide has a disk shape.

67. A microwave processing apparatus according to claim 64, where the wave guide has a shape which follows the exterior of the first dielectric material.

68. (Four Times amended) A microwave plasma processing apparatus comprising:
a plasma generation chamber separated from ambient air by a first dielectric material;

a substrate support for a substrate to be processed, located inside the plasma generation chamber;

an endless annular wave guide with a plurality of slots having defined positions in the endless annular wave guide for radiating microwaves therethrough provided outside of said first dielectric material;

gas inputs situated to introduce gas into said plasma generation chamber;

an evacuation system situated to permit pressure reduction in said plasma generation chamber;

wherein an interior of said wave guide is filled with a second dielectric material which is the same as or different from said first dielectric material so that the wavelength of microwaves in said wave guide is shortened, wherein the defined positions of the slots depend on the shortened wavelength of the microwaves in the presence of the second dielectric, thereby generating a uniform high density plasma.

69. A microwave processing apparatus according to claim 68, where the wave guide has a cylindrical shape.

70. A microwave processing apparatus according to claim 68, where the wave guide has a disk shape.

71. A microwave processing apparatus according to claim 68, where the wave guide has a shape which follows the exterior of the first dielectric material.

72. A microwave processing apparatus according to any one of claims 60-71, wherein a ratio of dielectric constants of said first and second dielectric materials is approximately equal to a reciprocal of a square of the ratio of circumferential lengths of said first and second dielectric materials.

73. A microwave processing apparatus according to any one of claims 60-71, further comprising a magnetic field generator.

74. A microwave processing apparatus according to claim 73, wherein the magnetic field in the vicinity of the slots has a magnetic flux density approximately equal to 3.57×10^{-11} (T/Hz) times of a frequency of the microwave.

75. A microwave processing apparatus according to any one of claims 60-71, wherein said substrate support is provided at a position distant from a generation area of said plasma.

76. A microwave processing apparatus according to any one of claims 60-71, further comprising an optical energy source to irradiate the substrate.

77. A microwave processing apparatus according to any one of claims 60-71, further comprising a high frequency supply connected to said substrate support.

78. (Four Times Amended) A microwave plasma processing method wherein a substrate is placed in a microwave plasma processing apparatus comprising a plasma generation chamber provided with a first dielectric material; means for supporting a substrate to be processed; microwave introduction means utilizing an endless annular wave guide provided outside of said plasma generation chamber and provided with plural slots having defined positions in the endless annular wave guide for irradiating microwaves therethrough; means for introducing gas for said plasma generation chamber; and evacuation means for said plasma generation chamber, wherein the interior of said wave guide is filled with a second dielectric material which is the same as or different from the first dielectric material, so that the wavelength of microwaves in said waveguide is shortened, wherein the defined positions of the slots depend on the shortened wavelength of the microwaves in the presence of the second dielectric, thereby effecting a plasma process.

79. A microwave plasma processing method according to claim 78, wherein the microwaves are introduced utilizing a cylindrically-shaped wave guide.

80. A microwave plasma processing method according to claim 78, wherein the microwaves are introduced utilizing a disk-shaped wave guide.

81. A microwave plasma processing method according to claim 78, wherein the microwaves are introduced utilizing a waveguide which has a shape which follows the exterior of the first dielectric material.

82. A microwave plasma processing method according to claim 78, further comprising using a processing chamber connected to said plasma generation chamber.

83. A microwave plasma processing method according to claim 82, wherein the microwaves are introduced utilizing a cylindrically-shaped wave guide.

84. A microwave plasma processing method according to claim 82, wherein the microwaves are introduced utilizing a disk-shaped wave guide.

85. A microwave plasma processing method according to claim 82, wherein the microwaves are introduced utilizing a waveguide which has a shape which follows the exterior of the first dielectric material.

86. (Three Times Amended) A microwave plasma processing method wherein a substrate is placed in a microwave plasma processing apparatus comprising a plasma generation chamber provided with a first dielectric material; a substrate support for the substrate to be processed; an endless annular wave guide provided outside of said plasma generation chamber and provided with plural slots having defined positions in the endless annular wave guide for irradiating microwaves therethrough; gas inputs to introduce gas into said plasma generation chamber; and an evacuation system situated to permit pressure reduction in said plasma

generation chamber, wherein the interior of said wave guide is filled with a second dielectric material which is the same as or different from the first dielectric material, so that the wavelength of microwaves in said wave guide is shortened, wherein the defined positions of the slots depend on the shortened wavelength of the microwaves in the presence of the second dielectric, thereby effecting a plasma process.

87. A microwave plasma processing method according to claim 86, wherein the microwaves are introduced utilizing a cylindrically-shaped wave guide.

88. A microwave plasma processing method according to claim 86, wherein the microwaves are introduced utilizing a disk-shaped wave guide.

89. A microwave plasma processing method according to claim 86, wherein the microwaves are introduced utilizing a waveguide which has a shape which follows the exterior of the first dielectric material.

90. A microwave processing method according to any one of claims 78-89, wherein a ratio of the dielectric constants of said first and second dielectric materials is approximately equal to a reciprocal of a square of a ratio of circumferential lengths of said first and second dielectric materials.

91. A microwave processing method according to any one of claims 78-89, wherein said plasma process is effected under application of a magnetic field.

92. A microwave processing method according to claim 91, wherein the magnetic field in a vicinity of the slots has a magnetic flux density approximately equal to 3.57×10^{-11} (T/Hz) times of a frequency of the microwave.

93. A microwave processing method according to any one of claims 78-89, comprising a step of placing said substrate on said substrate support at a position distant from a generation area of said plasma.

94. A microwave processing method according to any one of claims 78-89, wherein the plasma process is effected under irradiation of the substrate with optical energy.

95. A microwave processing method according to any one of claims 78-89, wherein the plasma process is effected by supplying high frequency to said support means.

96. A microwave processing method according to any one of claims 78-89, wherein said plasma process is film forming.

97. A microwave processing method according to any one of claims 78-89, wherein said plasma process is etching.

98. A microwave processing method according to any one of claims 78-89, wherein said plasma process is ashing.

99. A microwave plasma processing apparatus according to claim 19, wherein a spacing between selected slots of said plurality of slots is one half of a guide wavelength of microwaves in said annular waveguide.

100. A microwave plasma processing apparatus according to claim 99, wherein adjacent slots of said plurality of slots are at a spacing of one half or one quarter of a guide wavelength of microwaves in said annular waveguide.

101. A microwave processing apparatus according to claim 60, wherein a spacing between selected slots of said plurality of slots is one half of a guide wavelength of microwaves in said annular waveguide.

102. A microwave plasma processing apparatus according to claim 101, wherein adjacent slots of said plurality of slots are at a spacing of one half or one quarter of a guide wavelength of microwaves in said annular waveguide.

103. A microwave processing apparatus according to claim 68, wherein a spacing between selected slots of said plurality of slots is one half of a guide wavelength of microwaves in said annular waveguide.

104. A microwave plasma processing apparatus according to claim 103, wherein adjacent slots of said plurality of slots are at a spacing of one half or one quarter of a guide wavelength of microwaves in said annular waveguide.

105. A microwave plasma processing method according to claim 78, wherein a spacing between selected slots of said plurality of slots is one half of a guide wavelength of microwaves in said annular waveguide.

106. A microwave plasma processing method according to claim 105, wherein adjacent slots of said plurality of slots are at a spacing of one half or one quarter of a guide wavelength of microwaves in said annular waveguide.

107. A microwave plasma processing method according to claim 86, wherein a spacing between selected slots of said plurality of slots is one half of a guide wavelength of microwaves in said annular waveguide.

108. A microwave plasma processing method according to claim 107, wherein adjacent slots of said plurality of slots are at a spacing of one half or one quarter of a guide wavelength of microwaves in said annular waveguide.

109. A microwave plasma processing method according to claim 50, wherein a spacing between selected slots of said plurality of slots is one half of a guide wavelength of microwaves in said annular waveguide.

110. (Twice Amended) A microwave plasma processing method according to claim 109, wherein adjacent slots of said plurality of slots are at a spacing of one half or one quarter of a guide wavelength of microwaves in said annular waveguide.